

## DRAWINGS ATTACHED



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### (54) IMPROVEMENTS IN FUEL CELLS

(71) We, ALLMANNA SVENSKA ELEK-  
 TRISKA AKTIEBOLAGET, a Swedish Company,  
 of Västerås, Sweden, do hereby declare the  
 invention, for which we pray that a patent  
 may be granted to us, and the method by  
 which it is to be performed, to be particu-  
 larly described in and by the following  
 statement:—  
 In a fuel cell device in which a gas is  
 supplied to a gas chamber arranged adjacent  
 to an electrode in order to react as the fuel  
 or the oxidant at the electrode, it is im-  
 portant that the gas is distributed evenly  
 over the entire surface of the electrode.  
 Attempts have been made to achieve such  
 an even gas distribution by filling the entire  
 gas chamber with a gas-permeable solid  
 material consisting of, for example, particles  
 of a suitable material sintered together.  
 This method, however, at the best only gives  
 a very small improvement in the distribution  
 of the gas. The result can be improved if  
 channels for the gas are arranged in different  
 directions within the solid material, but this  
 still does not give a satisfactory distribution  
 of the gas. This last mentioned method  
 also requires extremely complicated pro-  
 cesses in order to provide such channels in  
 the solid material.  
 An object of the present invention is to  
 achieve particularly even distribution of the  
 gas across the entire surface of the electrode  
 in a very simple manner.  
 According to the invention a fuel cell  
 comprising at least one electrode forming  
 at least part of a boundary wall of a gas  
 chamber through which a gas reacting at  
 the electrode can pass between an inlet for  
 the gas and an outlet therefor, is charac-  
 terised in that a porous wall which is per-  
 meable to the gas is arranged across the gas  
 chamber in the path of the gas between the  
 inlet and the outlet, which wall covers at  
 the most 25% of the surface of the electrode  
 facing the gas chamber and is adapted to  
 effect a pressure drop in the gas when the  
 gas passes through it, said pressure drop be-  
 ing at least 50% of the drop in pressure of

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the gas in passing from the inlet to the  
 outlet.  
 The invention is of particular importance  
 when the gas contains an inert component  
 as is the case, for example, when air is used  
 as the oxidant or, for example, when cracked  
 ammonia is used as the fuel. When there  
 is an uneven distribution of the gas, high  
 concentrations of the inert gas component  
 can arise locally which reduce the perform-  
 ance of the electrode.  
 Preferably, the porous wall covers not  
 more than 10% of the surface of the elec-  
 trode facing the gas chamber. In many  
 cases it is possible to use walls covering as  
 little as 1% of the surface of the electrode  
 facing the gas chamber.  
 Preferably, the drop in pressure of the  
 gas in passing through the porous wall is at  
 least 90% of the drop in pressure of the gas  
 in passing from the inlet to the outlet in the  
 gas chamber.  
 It is suitable for the porous wall to be  
 arranged substantially perpendicular to the  
 shortest path for the gas between its inlet to  
 and its outlet from the gas chamber. The  
 wall may suitably be arranged at substan-  
 tially the same distance from the inlet as  
 from the outlet.  
 The porous wall may consist, for example,  
 of a porous synthetic resin body such as a  
 sheet of a fibrous thermoplastic resin con-  
 sisting of, for example, polytetrafluoroethy-  
 lene, polycarbonate or polyethylene glycol  
 terephthalate, or of a body of particles of  
 one of these thermoplastic resins sintered  
 together. It may also consist of a porous  
 metal body, for example, particles of nickel,  
 cobalt, molybdenum or other metal or  
 metal alloy resistant to the gas, sintered  
 together. When choosing the material for  
 the porous wall, it must be taken into con-  
 sideration whether or not an electrical con-  
 nection is desired between the electrode and  
 another boundary wall of the gas chamber,  
 which may also be an electrode.  
 In a fuel cell comprising several gas  
 chambers for gases of the same type, for

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example a fuel, a particular advantage is obtained if a porous wall is arranged in each gas chamber and the gas chambers are connected in parallel between a common supply channel for the gas and a common removal chamber therefor. An even distribution of the gas is thus obtained between the different gas chambers without the use of large and space-consuming supply and removal channels or narrow inlets to the gas chambers and narrow outlets therefrom which may easily become blocked. In comparison with connecting the gas chambers in series, this parallel connection of the gas chambers also leads to a saving of space, since with series-connection large channels are required, which means great distances between the electrodes in order to avoid considerable pressure drops. With the use of porous walls in parallel-connected gas chambers, the pressure drop across the porous wall in each gas chamber when the gas passes there-through is at least 50%, and preferably at least 90% of the pressure drop in the gas when it passes through the fuel cell, i.e. of the pressure drop in the gas between its inlet to the common supply channel and its outlet from the common removal channel.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a schematic sectional view of a fuel cell according to the invention, this view being a section through the supply and removal channels for the oxidant.

Figure 2 is a schematic sectional view of the same fuel cell, this view being a section through the supply and removal channels for the fuel, and

Figure 3 is a schematic front view of an electrode in the fuel cell with a porous wall applied to the side facing a gas chamber.

The fuel cell shown in the drawing comprises a number of oxidant electrodes 1a and fuel electrodes 1b in the form of circular discs attached in a gas-tight manner in frames 2a and 2b, respectively, of thermoplastic resin. Figures 1 and 2 show only a few of the electrodes which, in large fuel cell batteries, amount to a considerable number. The oxidant electrodes 1a face gas chambers 3a containing oxidant, which is oxygen gas in the example shown, and the fuel electrodes 1b face gas chambers 3b containing fuel, which in the example shown is a mixture of hydrogen and nitrogen obtained by cracking ammonia. The oxygen gas is supplied continuously to the gas chambers 3a from a common supply channel 4 for oxygen through inlets 5a, and unconsumed oxygen is removed continuously from the gas chambers 3a to a common removal channel 6 through outlets 7a. In a similar manner fuel, is supplied continuously to the

gas chambers 3b from a common supply channel 8 for fuel through inlets 5b, and unconsumed fuel is removed continuously from the gas chambers 3b to a common removal channel 9 for fuel through outlets 7b. The electrolyte, which is liquid, is supplied to electrolyte chambers 10 and is removed therefrom through channels 11 and 12, respectively (Figure 3) arranged for this purpose. These channels are connected to the electrolyte chambers in the same way as the supply and removal channels for the oxygen and fuel are connected to their respective gas chambers. Channels 13 and 14 are also arranged in the thermoplastic resin frames for the positive or negative current screens with which the various cells may be series-connected or parallel-connected, respectively. Two end plates 15, 16 are arranged at the ends of the stack formed by the electrodes and the intermediate gas and electrolyte chambers. The whole stack may be held together in any suitable manner, for example by two strong plates (not shown) arranged outside the end plates 15 and 16 and having bolts arranged through them. The channels, the gas chambers and the electrolyte chambers are effectively sealed by washers (not shown) or by welding together the thermoplastic resin frames around the channels and chambers in question.

The oxidant electrodes 1a are of conventional type and may consist of nickel activated by silver. The fuel electrodes 1b are also of conventional type and may, for example, be made of nickel activated by platinum. They may be provided in the usual manner with an extra layer facing the electrolyte having finer pores than in the active layer. The electrolyte may be an aqueous solution of potassium hydroxide.

A porous wall 17a is arranged straight across each gas chamber 3a and a porous wall 17b is arranged straight across each gas chamber 3b. In the example shown, these walls are arranged perpendicular to the shortest path for the gas between the inlets 5a (5b) and the outlets 7a (7b), and at substantially the same distance from the inlet and the outlet. In the example shown, the porous wall consists of a sheet of polyethylene glycol terephthalate having a width of 10 mm and a thickness of 0.5 mm. The wall is held in position between the electrodes, or between one electrode and one end plate, by being pressed against these as well as against the surrounding frames so there are no leakage paths for the gas. It may also be fixed to the electrodes, the end plates and the frames with the help of a binder, such as a resinous binder.

In one specific example of the fuel cell shown in the drawing, the surface of each is approximately 300 cm<sup>2</sup>. The pressure of

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the oxygen at the inlet 18 to the common supply channel 4 for the oxidant may be about 2.52 bar and the pressure at the outlet 19 of the common removal channel 6 may be 2.50 bar, the pressure drop of the gas between the inlet 18 and the outlet 19 thus being 0.02 bar. The porous wall 17a in each gas chamber 3a has a porosity providing a pressure drop of 0.018 bar when the gas passes through it, i.e. 90% of the drop in pressure of the gas when passing through the fuel cell is effected by the wall 17a. The pressure of the fuel at the inlet 20 to the channel 8 and also at the outlet 21 of the channel 9 may have the same values as for the oxygen at corresponding points in the oxygen system. The porous wall 17b in each gas chamber 3b has the same porosity and gives the same pressure drop as a wall 17a.

#### WHAT WE CLAIM IS:—

1. A fuel cell comprising at least one electrode forming at least part of a boundary wall of a gas chamber through which a gas reacting at the electrode can pass between an inlet for the gas and an outlet therefor, characterised in that a porous wall which is permeable to the gas is arranged across the gas chamber in the path of the gas between the inlet and the outlet, which wall covers at the most 25% of the surface of the electrode facing the gas chamber and is adapted to effect a pressure drop in the gas when the gas passes through it, said pressure drop being at least 50% of the drop in

pressure of the gas in passing from the inlet to the outlet.

2. A fuel cell according to claim 1, in which the porous wall is arranged substantially perpendicular to the shortest path for the gas between the inlet and the outlet.

3. A fuel cell according to claim 1 or 2, in which the porous wall is arranged at substantially the same distance from the inlet as from the outlet.

4. A fuel cell according to any of claims 1 to 3, in which the porous wall is made of a thermoplastic resin.

5. A fuel cell according to claim 4, in which the thermoplastic resin is polytetrafluoroethylene.

6. A fuel cell according to any of claims 1 to 5, and comprising several gas chambers of the same type, each provided with an inlet and an outlet for the gas, and a porous wall arranged in each of the gas chambers, in which the inlets are connected to a common supply channel for the gas and the outlets are connected to a common removal channel for the gas, so that the gas chambers are connected in parallel between the supply and removal channels.

7. A fuel cell constructed and arranged substantially as herein described with reference to the accompanying drawing.

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Fig.1

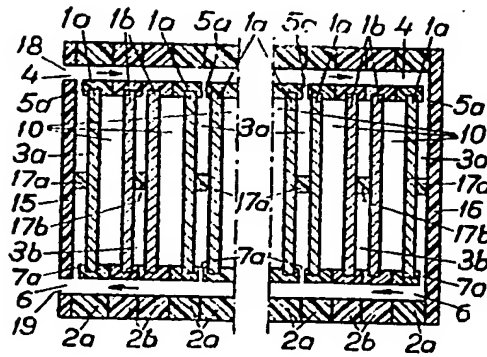


Fig.2

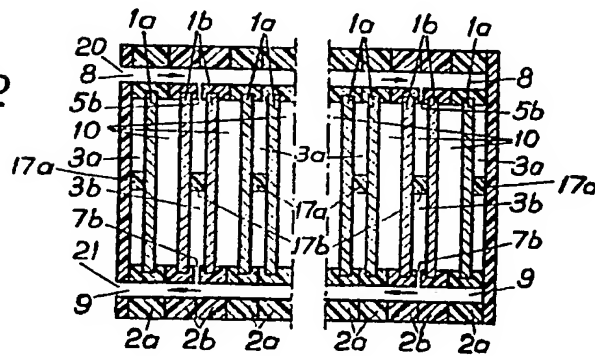


Fig.3

